REMARKS

Entry of the above amendments is respectfully requested. Claims 1, 10, 11, 30, 45 and 69 have been amended. Claims 1-23 and 30-70 remain pending in the case.

In the December 7, 2001, Office Action, the Examiner rejected claims 1-5, 7-17, 19-23 and 29-70 under 35 U.S.C. § 102(e) as being anticipated by *Grahn*. In addition, the Examiner rejected claims 6 and 18 under 35 U.S.C. § 103(a) as being unpatentable over *Grahn*. In view of the rejections, applicant presents the attached amendments to the independent claims to define the present invention over the prior art including *Grahn*.

The preferred embodiment is directed to a three-axis sensor that directly detects forces exerted thereon. More particularly, the sensor assembly is adapted to detect strain forces in three dimensions at a particular point or region, substantially in real-time (i.e. without any delay to perform any other operation), and without having to infer the strain force. For example, when utilizing resistive strain sensors, the sensors deform and produce a corresponding signal proportional to the detected force, substantially in real-time.

In contrast, the *Grahn* patent is directed to a force measuring technique that indirectly measures strain based on measuring the translation of a target element relative to a transducer. More particularly, the Grahn sensor measures translation via an ultrasonic pulse-echo ranging between the movable target and the transducer. *Grahn* detects the distance between the target and the transducer by measuring the time it takes an ultrasonic signal to traverse an intervening medium. Based on this time interval measurement, or "transit time," and with knowledge of the speed of sound in the medium and the medium's modulus, the force can be calculated.

To clarify the above-noted difference between the *Grahn* sensor and the preferred embodiment of the present invention, applicant has amended independent claims 1, 10, 11, 30, 45 and 69 to define that the preferred embodiment as directly determining the strain exerted on the elements of the sensor. Clearly, to the contrary, the *Grahn* measurement is not made

"substantially in real-time," as set forth in pending amended independent claims 11 and 45. In response to a strain force, Grahn measures the time that elapses as an ultrasonic signal traverses a medium.

Moreover, the *Grahn* sensor does not deform; rather its components translate. In fact, if the target or transducers of the *Grahn* sensor are deformed during operation, its ability to detect the ultrasonic pulse could be severely compromised. Therefore, *Grahn* essentially teaches away from a sensor that deforms, as defined in amended independent claims 1 and 69. In the present invention, when the sensor is implemented with resistive strain gauges, as a force is exerted on the pyramidal-shaped body, the resistive strain gauges deform and produce signals directly related to the force exerted thereon.

This direct measurement of the strain has several advantages. By providing a direct measurement, no separate "target" element is required to implement the invention. As a result, whereas the *Grahn* sensor may experience an error due to imperfect mounting or placement of the target, or imperfect detection of the ultrasonic wave, the preferred embodiment of the present invention directly measures the strain, avoiding any such error and thus is more robust. Moreover, such a design is inherently less expensive. Overall, the *Grahn* sensor would not be useful for the applications contemplated by the present invention, including embedding the sensor in an elastomeric material, such as a tire, where robustness is critical.

The Examiner also contends that *Grahn* in Columns 15 and 16, teaches adding the outputs of first and second sets of sensors to determine the strain force in a third orthogonal direction, as set forth in Claim 10. Applicant respectfully contends that *Grahn* does not provide such a teaching, and therefore contends that independent claim 10 is allowable for this additional reason.

In view of the present amendments and the above remarks, independent claims 1, 10, 11, 30, 45 and 69 are novel and non-obvious over the cited *Grahn* reference. In addition, dependent

claims 2-9 (claim 1), 12-23 (claim 11), claims 31-44 (claim 30), claims 46-68 (claim 45), and claim 70 (claim 69), are allowable as being dependent from an allowable independent claim.

CONCLUSION

Because the present invention as defined in the pending claims is directed to a sensor that directly measures strain substantially in real-time, each of the claims 1-23 and 29-70 is novel and non-obvious over the *Grahn* reference. As a result, applicant respectfully contends that each of these claims is in condition for allowance and an indication to that effect is respectfully requested.

A one (1) month Petition For Extension of Time Under 37 CFR 1.136(a) together with the appropriate fee is enclosed for the above-identified application. The Director is authorized to direct any additional fees associated with this or any other communication, or credit any overpayment, to Deposit Account 50-1170.

If the Examiner has any concerns or suggestions, he is invited to contact the undersigned at the telephone number appearing below.

Respectfully submitted,

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APPENDIX SHOWING THE CHANGES FOR SN 09/724,655

Please amend claims 1, 10, 11, 30, 45 and 69 as follows:

1. (Twice Amended) A sensor assembly for use in an elastomeric material, the assembly comprising:

a first pair of sensors disposed along a first pair of respective planes that intersect, each of said first sensors deforming in response to [detecting] a force in a first direction and generating a corresponding output;

a second pair of sensors disposed along a second pair of respective planes that intersect, each of said second sensors deforming in response to [detecting] a force in a second direction and generating a corresponding output; and

wherein the force [measured] in the first direction is equal to the difference between the outputs of said first sensors, and the force measured in the second direction is equal to the difference between the outputs of said second sensors.

10. (Amended) A three-axis sensor assembly embedded in an elastomeric material, the sensor comprising:

a first sensing element generating a first output indicative of a strain in a first direction applied directly to said first sensing element;

a second sensing element generating a second output indicative of strain in a second direction orthogonal to said first direction applied directly to said second sensing element; and

wherein the sum of said first and second outputs is indicative of strain in a third direction orthogonal to both the first direction and the second direction.

11. (Amended) A sensor assembly embedded in an elastomeric material, said sensor assembly comprising:

a pair of first strain sensors disposed on first opposed faces of a flexible pyramid-shaped body, said first strain sensors detecting a force in a first direction; and

wherein said first strain sensors generate, <u>substantially in real-time,</u> corresponding output signals in response to the force in the first direction, <u>substantially in real-time,</u> and wherein the force in the first direction is generally equal to the difference between the output signals of said first strain sensors.

30. (Twice Amended) A process of embedding a sensor in an elastomeric material, the process comprising:

providing a three-axis sensor assembly including two pairs of strain gauges, a first pair disposed on first opposed faces of a pyramid-shaped body <u>so as to directly detect strain in a first direction</u>, and a second pair disposed on second opposed faces of the pyramid-shaped body <u>so as to directly detect strain in a second direction</u>; and

adjusting the aspect ratio of the pyramid-shaped body to a sensitivity of the three-axis sensor.

45. (Amended) A process of embedding a sensor in an elastomeric material, the process comprising:

providing a three-axis sensor assembly including first and second pairs of strain sensors, the first pair disposed on first opposed faces of a pyramid-shaped body, and the second pair disposed on second opposed faces of the pyramid-shaped body <u>so as to detect strain in a first direction substantially in real-time</u>, and the second pair disposed on second opposed faces of the pyramid-shaped body <u>so as to detect strain in a second direction substantially in real-time</u>; and

placing the sensor assembly in the elastomeric material when the elastomeric material is in an uncured state.

69. (Amended) A three-axis sensor assembly embedded in an elastomeric material that measures strain forces on the elastomeric material, the sensor assembly comprising:

a three-axis sensor assembly including two pairs of strain sensors, a first pair disposed on first opposed faces of a pyramid-shaped body <u>so as to deform in response to strain in a first direction</u>, and a second pair disposed on a second opposed faces of the pyramid-shaped body <u>so as to deform in response to strain in a second direction</u>;

a printed circuit responsive to the outputs of said strain sensors to generate a corresponding signal indicative of [a] the corresponding strain [force] acting on the elastomeric material; and

wherein the sensor assembly is electrically coupled to the printed circuit.